The Journal of HEREDITY

FOUR BROTHERS WHO HAVE THE SAME BIRTHDAY
(SEE PAGE 207)

Hereditary Nosebleed
Genetics of Horns in Sheep
Twin Calves With Different Sires
Drug-Store Genetics
European Anthropology

VOLUME 31 JULY, 1940 NUMBER 7

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The

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TWINS, BUT NOT FULL SISTERS

Frontispiece

Appropriately enough on Mother's Day, May 12, 1940, a high grade Guernsey cow used as a nurse cow in the Iowa State College beef herd, gave birth to half-sister twin calves.

Nurse cows, usually of dairy breeding, are often kept in beef breeding herds for developing prospective show steers. No other food is quite equal to whole milk for keeping a calf growing at the maximum rate of which it is capable. Show steers are primarily a means of advertising or demonstrating in breeders' herds and are needed in college herds as classroom material for teaching judging. In producing them, cost is a secondary consideration and nurse cows are an almost indispensable aid to success in the hot competition of the show-ring. For convenience the nurse cows are usually bred to the same purebred bulls used on the beef cows, since the nurse cows' own calves are to be vealed or sold soon after birth. This particular cow had been bred to the Angus sire at her first two heat periods but failed to conceive. At the third heat period she was bred to both an Angus and a Hereford bull, a practice that is often followed with cows that fail to conceive the first or second time bred.

As can be seen from the picture, one of the calves has the typical Hereford markings, except that the amount of white is a little less than average, while the other calf shows the Angus characteristics. While no new biological principle is involved (double matings have been used systematically to provide a more perfect control in studies of cross-breeding swine), the rarity of twins in cattle combined with the rarity of breeding to two bulls under circumstances such that the sire of each calf could be identified make the present case so unusual that it deserves to be placed on record. Few cattlemen have actually seen twin calves known not to have been of identical paternity.

E. L. VIETH

Iowa State College

THE ALPHABETICAL PERRICONE QUADRUPLETS

A Four-egg Set, All Males

IVA C. GARDNER AND H. H. NEWMAN

This is the second article by this pair of investigators to be published in the JOURNAL. *It is hoped that others will follow. Dr. Gardner, Professor of Psychology in Baylor University, has been particularly fortunate in having had the opportunity of studying numerous pairs of twins, several sets of triplets, and especially three interesting sets of Texas quadruplets. It has seemed advisable for her to work in collaboration with a specialist in the biology of twins and multiple births, and the various reports are prepared jointly by the two authors. In the present case all the information was gathered by Dr. Gardner, while Dr. Newman has studied the palm and finger prints and has been responsible for deciding that these quadruplets are a tetrazygotic—a four-egg—set. It may be of some interest to state that the above diagnosis was first made on the basis of palm and finger prints alone and was subsequently amply confirmed by the additional data now in hand. The case was written up by Dr. Newman in concurrence with Dr. Gardner.*—EDITOR.

QUADRUPLET sets may have at least four modes of origin: they may be derived from one, two, three, or four eggs. There are, moreover, two different kinds of two-egg quadruplets. The first kind consists of a set of one-egg triplets plus a single sibling, the second of two pairs of one-egg twins. A set of one-egg quadruplets must be all of the same sex. The first kind of two-egg quadruplets may be all of the same sex or three of one sex and one of the opposite sex. The second kind of two-egg quadruplets may be all of the same sex or two of one sex and two of the opposite sex. Three-egg and four-egg quadruplets may be all of the same sex, three of one sex and one of the other, or two of one and two of the other sex.

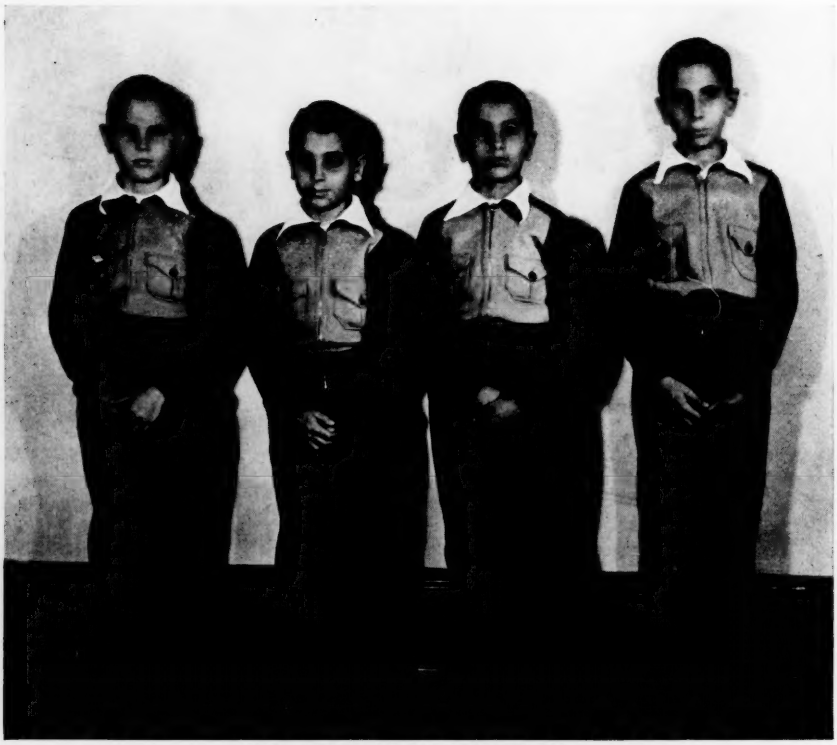
Frequency and Sex Ratios of Quadruplets

Gruelich, on the basis of a study of the vital statistics of several populous countries, found only 179 sets of quadruplets in a total of slightly over 120,000,000 births, or about one-and-one-half sets per million births. Hamlett found that in the United States during the years from 1915 to 1930 there were born 40 sets of white and 8 sets of colored quadruplets. Relatively few sets of quadruplets are all alive at birth and in the majority of such sets one or more babies die in infancy. Hence there are at any time only a few sets of quadruplets in any country that all live and grow up. On a guess, we would be inclined to say that there are not over a dozen surviving whole sets in our country today. The rarity of surviving quadruplet sets makes it important that they should all be adequately studied.

Peculiarly enough, the Perricone quads seem to be the only all-male set now living in the United States. If there are others we should be glad to be informed about them.

There is something very odd about the sex ratios of quadruplet sets. Hamlett has made a study of the sex distribution of the 48 sets of quadruplets previously mentioned. Obviously, there are only five possible sex combinations in quadruplets: all four males, 3 males to 1 female, 2 males to 2 females, 3 females to 1 male, and all 4 females. One would expect a large majority of sets to contain both sexes, but the actual sex ratios were as follows: 13 ♂ ♂ ♂ ♂, 6 ♂ ♂ ♂ ♀,

A B C D



ALPHABETICALLY ARRANGED

Figure 1

The family says that each of the quads has an older brother he resembles more closely than any of the alphabet quartet resemble each other. A set of quads is born on the average once in two-thirds of a million births, and few all survive even through infancy. That all four should be boys would occur by chance only in one set out of sixteen. All of which goes to prove that Anthony, Bernard, Carl, and Donald are highly improbable.

12 ♂ ♂ ♀ ♀, 7 ♂ ♀ ♀ ♀, and 10 ♀ ♀ ♀ ♀. Thus 23 out of 48, or nearly half of the sets, were all of one sex. From this one would suspect that the majority of the same-sexed groups are monozygotic. In fact some of us have been inclined to believe that all higher sets of offspring such as quadruplets and quintuplets involve some one-egg twinning. It has seemed to us highly improbable that as many as four eggs would ever be ovulated simultaneously, all be fertilized, all live to term and be born alive and healthy.

The case of the Perricone quadruplets seems to constitute such a highly improbable one, and the odds are still further lengthened by the fact that they are all males. The probability of four-egg quadruplets being all males is only one in sixteen. Thus the Perricones may be regarded as almost a miracle.

So much for the biological background of this remarkable set of quadruplets. Let us now proceed to a somewhat detailed study of them. But first of all, let us explain that these boys are

nicknamed the Alphabetical Quadruplets because they are named Anthony, Bernard, Carl, and Donald (A, B, C, and D). It will be convenient in the following account to refer to them by their initials.

Zygotic Diagnosis of the Perricone Quads

In diagnosing one-egg twins about the first criterion to be applied is that the two members of a pair must be rather strikingly similar so that it is not too easy to distinguish one from the other. In the case of the Perricones there is no likelihood of confusing any one with another. Reference to Figure 1 will show that *A* and *D* are not at all similar to each other or to *B* and *C*. The only possible chance of mistaking one quad for another is with respect to *B* and *C*, who in the photograph appear about as similar as do some pairs of one-egg twins. Examination shows, however, that *B* has medium chestnut hair and light-brown eyes, while *C* has dark brown hair and dark brown eyes. *C* is also fully two inches taller than *B*. *B*'s skin is medium dark with some freckles, while *C*'s skin is very dark with no freckles. On the basis of these few differences alone, it must be decided that *B* and *C* are not one-egg twins. Since *A* and *D* are obviously "simultaneous siblings," there are no two in the lot that could possibly be diagnosed as monozygotic. It will be recalled that this decision was arrived at by one of us on the basis of an analysis of the palm and finger prints alone. For a more complete comparison of the physical characters of the whole set the reader is referred to Table II.

The Dermatoglyphics of *A, B, C, D*

The palm and finger prints were made by the Beaumont Police Identification Bureau and are as good as we ourselves could make. For this service we are much indebted to the Head of the Bureau. The formulae for the finger patterns are given below.* Ridge counts of finger patterns were first made by the police officials and confirmed with slight modifications by one of us. The full counts were made of all the ridges except that in whorls only the side having the larger number of ridges is counted. The counts of the two hands separately and the totals are as follows:

	Left	Right	Total
A	71	58	129
B	57	61	118
C	84	81	165
D	71	79	150

On the basis of finger-print formulae alone *A* and *D* are identical, for they both have the commonest pattern, ulnar loops, on all fingers of both hands. On the basis of the Stocks' test, using finger patterns alone, *A* and *D* would then be classed as a monozygotic pair, but they are quite dissimilar in almost all other ways. *B* and *C*, who are most similar in appearance, have only 4 out of 10 patterns su-

***Finger Patterns**

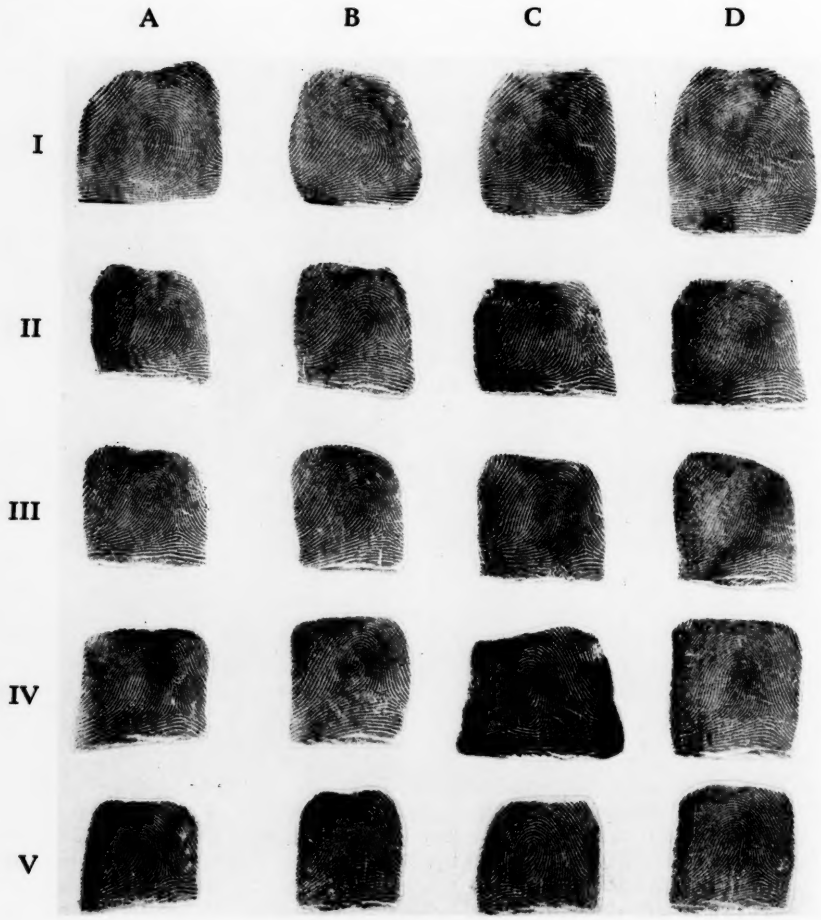
Digits	*Left Hands* I	II	III	IV	V	*Right Hands* I	II	III	IV	V
A	U	U	U	U	U	U	U	U	U	U
B	U	U	U	W^{lu}	U	U	U	U	W	U
C	U	U	U	W	W^{u}	W^{du}	W^{cu}	U	W^{u}	W^{lu}
D	U	U	U	U	U	U	U	U	U	U

Right Palmar Formulae:

A: 11(10) . 9 . 7(6) . 5′ - t′t″ - L^{e} . O . O . L . O
B: 11(10) . 9 . 7(6) . 5′ - tt′ - L^{r} . O . O . L . O
C: 9 . 9 . 5″ . 5′ ? - - A^{u} . O . O . L . V
D: 11(10) . X . 7(6) . 5′ - t - A^{u} . O . D . V . M

Left Palmar Formulae:

A: 10 . 9 . 6 . 5′ - t - A^{u}/A^{e} . L^{e}/O . O . L . O
B: 9 . O . 5′ . 4 - t″ - L^{u} . O . O . V . V
C: 9 . X . 5″ . 5′ - t - A^{u} . O . O . V . O
D: 9 . 7 . 5″ . 5′ - t″ - L^{r} . O . O . O . 1/V



FINGERPRINTS NOT ALIKE

Figure 2

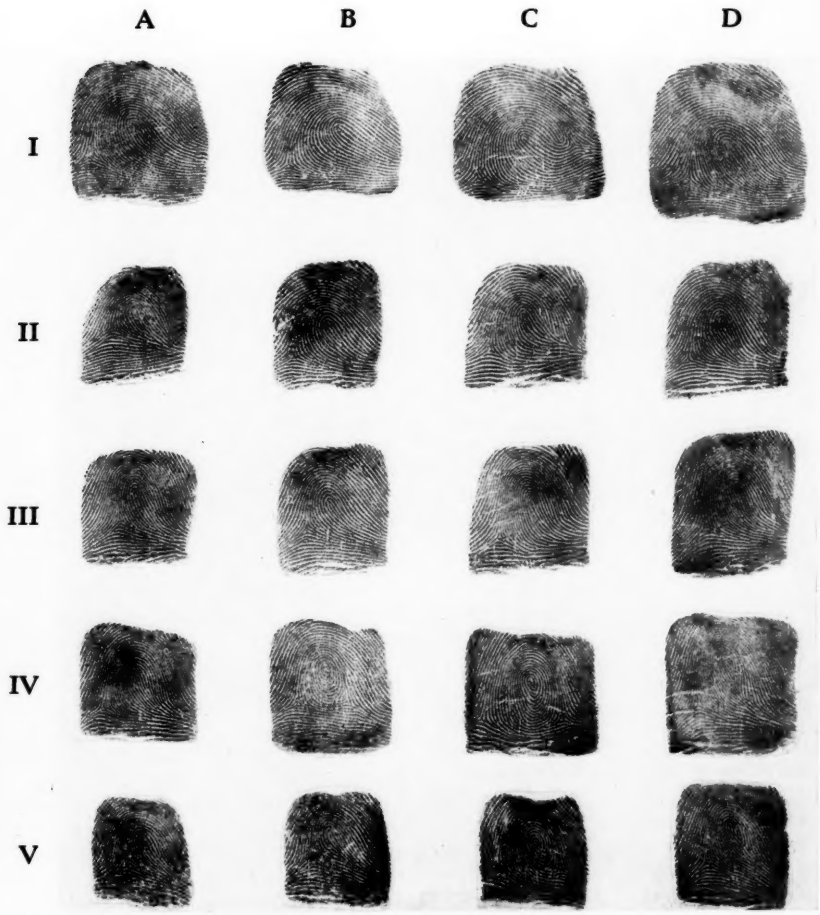
Prints of the left fingers of the quads, the right fingerprints being shown in Figure 3. *A* and *D* have the very common loop pattern on all fingers, and the gross similarities are great enough to suggest that they might be identical. They differ so greatly in many other characteristics that this rather slight evidence is overruled.

perficially alike and this alone, according to the Stocks' test, would make them dizygotic. In addition to this, *B* has the lowest total ridge count and *C* the highest, the difference being 47 ridges, which exceeds that found in any of the monozygotic pairs in our large collection.

Palmar Dermatoglyphics

The formulae for the palms of the four individuals will, for convenience in arrangement, be given first for the right and then for the left palms. (See bottom of page 309.)

A dermatoglyphic test as to whether



PRINTS OF THE RIGHT FINGERS

Figure 3

The superficial resemblances between some of the fingerprint patterns is shown by analysis of percentage of differences between the quads to be so slight as to offer definite evidence that they arose from four separately fertilized eggs. The similarities between the patterns, which are genetically determined to a large extent, perhaps parallel the similarities of the quads on some of the mental tests.

any two or more of a set of quadruplets is monozygotic has been devised by MacArthur. Quadruplets may be arranged in six pairs: *AB, AC, AD, BC, BD,* and *CD*. Each of these can be tested as a pair of twins. The test consists of a comparison of homolateral as against bilateral differences. Homolateral comparisons consist of differences between right hand of one twin with right hand of the other, and of left hand with left. Bilateral comparisons are those between the two hands of each individual. Four comparisons are made: ridge counts, finger

patterns, palm lines, and palm patterns. The per cent difference was obtained for each of these and the four were averaged to give the average per cent difference of homolateral and bilateral comparisons for each of the six pairings of the Perricone quadruplets. The results of this calculation are given in Table I below.

In every pairing the homolateral differences are greater than the bilateral, which is the rule for dizygotic pairs of twins, while the opposite is the rule for monozygotic twins. Moreover the average homolateral difference is 35.09 per cent, which is nearly as high as the average of dizygotic twins (37.9 per cent), and very much higher than the average of monozygotic twins, which is 18.9 per cent. This purely objective test of monozygosity based on dermatoglyphics alone strongly points to the four-egg origin of the ABCD quadruplets. This test also is in full accord with the other method of diagnosis based on hair color, eye color, skin color, facial features, etc. Having demonstrated, at least to ourselves, that the present set of quadruplets is a four-egg set, let us proceed to give an account of their careers and of the psychological studies that have been based upon them.

Life Story of the ABCD Quads

These boys were born October 31, 1929, on a small truck farm near the outskirts of Beaumont, Texas. Both father and mother are Italians by birth, the former a Sicilian, the latter a mainlander. The father came to this country when 18 years of age, the mother when about six. There is not much conversation between the father and the quadruplets, for the former does not speak English very well and the boys have not learned Italian. The mother acts as interpreter betwen the boys and their father.

This family tends to produce all male children, for there are five older brothers, the only girl dying at an early age. This preponderance of male offspring somewhat detracts from the remarkableness of the fact that these four-egg quads are all boys.

The quads have lived on the small farm all their lives, but entered the Beaumont Public School when they were seven. After three years they were transferred to the Catholic School, which is less crowded. *A*, *B*, and *C* are now in the fourth grade, while *D*, the tallest of the lot, has been temporarily placed in third grade because of a slight language handicap.

The mother has sought to keep the boys as much alike as possible, but in spite of this effort they are as unlike in every way as are the five older brothers. In fact, according to the mother, who ought to know, each of the quads is more like one of his older brothers than like any other member of his set. It is generally recognized in the family that each of the quads has a "double" in an older brother.

The chief interest from the psychological point of view that these quads arouse is that in them we have a set-up in which four sibling brothers of the same age are being reared with every effort to make their lives and their personalities as similar as possible. Hence, whatever differences are detected, mental as well as physical, are almost exclusively genetic. It might well be asked whether this study is any better than would be one involving four singly-born brothers. We believe the present set-up is superior in two main ways. First, it is unnecessary to take account of age differences. Second, companionship differences are reduced to a minimum, for a group of four quads is self-sufficient and there is but little need to seek separate companions outside the group.

Dr. Gardner has become very well acquainted with the quads, having visited their home and having them in her own laboratories on two occasions. In

TABLE I. Homolateral and Bilateral Per Cent Differences in Dermatoglyphics of Pairs *A-B*, *A-C*, *A-D*, *B-C*, *B-D*, and *C-D*

	Homolateral	Bilateral
A-B	29.47	25.72
A-C	41.82	26.78
A-D	32.72	26.48
B-C	37.66	28.18
B-D	31.06	29.77
C-D	37.84	27.08

her judgement the quads have had as similar an environment as it is possible for four individuals to have. Each boy has eight brothers, and each has to adjust to the five older brothers as well as to the three others in his own set. They are more influenced by each other than by any outside factors. They are different in almost every respect, not only physically, but mentally, emotionally, volitionally, and in the types of things they do best. The quads are as strong, healthy and active as any ten-year-old boys one would be likely to find anywhere. The physical measurements given in Table II represent the average of three separate measurements of each dimension and are therefore more than usually reliable.

TABLE II. Physical Comparisons of the ABCD Quads.

Character	A	B	C	D
Standing height	139.5 cm.	134.2 cm.	136.5 cm.	148.2 cm.
Sitting height	71.25 cm.	69.5 cm.	69.75 cm.	70.5 cm.
Weight (at 9 years)	69 lbs.	65 lbs.	63 lbs.	71 lbs.
Head length	17.82 cm.	17.8 cm.	17.2 cm.	18.2 cm.
Head width	13.8 cm.	13.5 cm.	13.56 cm.	16.62 cm.
Cephalic index	77	75.6	78.8	74
Hair color	light red-brown	light brown	dark brown	dark brown
Hair texture	very fine	medium fine	medium fine	coarse
Eye color	bluish gray	light brown	dark brown	medium brown
Skin color	fair	medium dark	very dark	dark
Freckles	numerous	few	none	none
Handedness	left	right	right	right
Hair whorl	clockwise	counter-clockwise	clockwise	clockwise
Moles	one on leg	none	none	none

TABLE III. Results of Various Mental Tests Given the ABCD Quads.

1939	A	B	C	D	Diff. A & B	Diff. A & C	Diff. A & D	Diff. B & C	Diff. B & D	Diff. C & D
Stanford-Binet Form L.										
M. A.	7-10	8-9	8-10	8-10	11 mo	12 mo	12 mo	1 mo	1 mo	0
I. Q.	85.5	94	95	95	8.5	9.5	9.5	1	1	0
Army-Beta										
M. A.	9	10-6	12	9-6	18 mo	36 mo	6 mo	30 mo	12 mo	30 mo
I. Q.	97	113	129	102	16	32	5	16	11	27

1940										
Stanford-Binet Form M.										
M. A.	9-2	9-4	10-2	9-2	2 mo	12 mo	0	10 mo	2 mo	12 mo
I. Q.	89	94	99	89	5	10	0	5	5	10
Army-Beta										
M. A.	10-10	10-3	10-3	10-10	7 mo	7 mo	0	0	7 mo	7 mo
I. Q.	105	100	100	105	5	5	0	0	5	5
Art Judgment Meier-Seashore	61	67	75	73	6	14	12	8	6	2
Schedule Thurstone-Personality	70	23	34	76	47	36	6	11	53	12
A-S Reaction Study	+37	+3	+13	-4	34	24	41	10	7	17
Interpretation of A-S Study	A^1	Average	A^2	Low Average						

Mental Tests

Dr. Gardner, being a psychologist, is especially interested in a rather prolonged study of the mental and temperamental development of the quads. In a sense this report is only a preliminary one, for the study will be continued for some years. A rather large battery of mental and personality tests have already been given and others will be used in the near future. For our purposes the whole psychological study as it now stands is concisely summarized in Table III.

Concerning these tests and the conclusions that may be derived from them, Dr. Gardner makes the following comments:

In February of 1939 the Stanford-Binet and the Army Beta Tests were given. Mental ages and I. Q's may be found in Table III. In February of 1940 the alternate form of Stanford-Binet was given and the Army Beta repeated. We find from 0 difference to 5-10 points difference in I. Q's on the Stanford-Binet Test. In 1940, Carl's I. Q. is 10 points higher than either Anthony's or Donald's and 5 points higher than Bernard's. Anthony and Donald are 5 points higher than Carl or Bernard on the Army Beta, the performance test. There are some fluctuations from the 1939 test scores. This is a matter that will be studied year by year. In giving the test the author found Carl and Bernard quicker in responses. On the performance test Carl and Bernard rushed ahead, made quick decisions, while Anthony and Donald deliberated longer, remaining with each section until time was called. This persistence of Anthony and Donald won higher scores for them on the Beta test. The boys differed a good deal in the types of questions answered correctly. Donald missed questions that had to do with reading, but he was very good in answering absurdities.

In the Art Judgment Test they are more nearly alike. Their Italian heritage led us to give them this test. It has been standardized on junior high school students, and the quads are in third and fourth grades. Donald and Carl fell on

the 27th percentile of 7th and 8th grade students, while Anthony and Bernard fell with the lowest tenth of 7th and 8th grade students. We adapted the questions of Thurstone's Personality Schedule to their understanding and gave them the questionnaire individually to see if there would be difference in rating. From the test scores we would say that Bernard is the best adjusted. Carl is next, then Anthony and Donald. The family of the quads as well as their teachers agree that this rating is correct. The A-S Reaction Study was adapted to their understanding and here Anthony is most dominant, Carl next, Bernard, and then Donald. This seems to be correct also.

The boys play accordions. Mr. Larry Jean Fisher is their teacher. They seem to show considerable talent in music. Next year we hope to give the Seashore Music Test. We tried it last year, but they were not sufficiently advanced in school to take it. The desire for each of the boys to do as well as the others possibly keeps them as near together as they they are in achievement, for when one gets behind, the others seek to help the laggard. This is both Mrs. Perricone's opinion as well as that of their teacher, Mr. Fisher.

Dr. Gardner is much indebted to Mr. Arthur Eckerman for assistance in administering the tests and to Mr. Will Roberts, instructor in psychology, also to Mr. Bernard Fudge and Miss Carol Royston, students in psychology, for assistance in the study.

In conclusion it is interesting to note that in mental ability, all tests included, the quads are just about average. There is also not much significant difference among them. Had the set been a monozygotic set we would not have expected a much closer correspondence. These four-egg quads are more similar in ability than the average of twenty pairs of identical twins reared apart. Temperamentally, the differences among them are much greater, even greater than are their physical differences, which have been shown to be quite marked.

It would, in our opinion, be unsafe at the present time to attempt to draw any general conclusions from this isolated study. If anything could safely be said at this time it would be, that in spite of the common environment and all efforts of the quads themselves to keep alike, their genetic differences, especially the physical and temperamental ones, persist in asserting themselves. The fact that all four boys are about average in mental ability and that there is but little significant difference among them in this respect might be offered as evidence that common environment and training have tended to make them similar mentally. It seems to us more probable, however, that the stock from which they have been derived is a somewhat homogeneous, average one from which any wide departure from mediocrity would not be expected. This view that their I. Q. similarities are not due to a similar environment will be supported in a report on another set of quadruplets, soon to be published.

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"SYNTHETIC" ZANTE CURRANT GRAPES

Breeding Investigations Indicate Possible Origin, and Point Way toward Production of New Varieties

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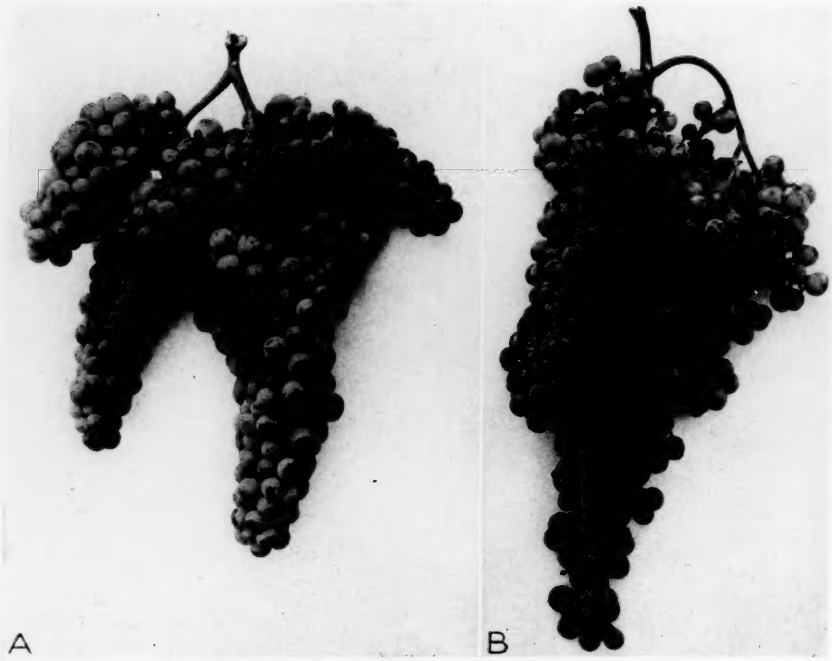
U. S. Department of Agriculture, Fresno, California

THE CORINTHE NOIR GRAPE
Figure 4

A producing vine of the variety from which Zante "currants" are made. This is one of the oldest seedless varieties known, tracing back at least to Roman times. It has the strange peculiarity that it will not produce a profitable yield unless the main stalk of the vine is girdled. This naturally affects the vitality of the vine, and the development of varieties equally productive which do not require girdling is a worthwhile plant breeding objective.

GRAPE breeding investigations at Fresno, California, have produced seedless grapes similar in type to those which are known commercially as "Zante Currants." The "Zante Currants" are the dried product of small seedless grapes which have been grown since ancient times. According to Eisen,[1] grapes of this seedless type were mentioned by Pliny in 75 A.D. After this early record these grapes apparently disappear from historical records for ten centuries. During the eleventh century however, the dried product of these seedless grapes was mentioned as an important item of trade between the Mediterranean Nations. The name "Currant" or "Zante Currant"[2] has probably developed by a gradual process of evolution from the name Corinth, a part of



CURRANT-TYPE GRAPES BY BREEDING

Figure 5

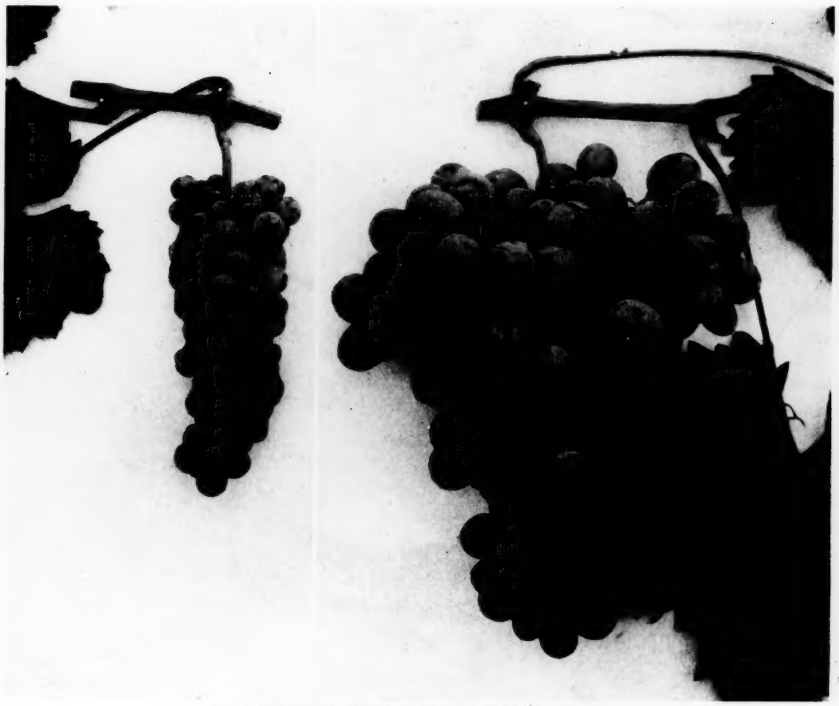
A—shows a big cluster of an F_1 of Muscat Hamburg × Black Monukko. *B*—shows an F_2 segregate of Muscat of Alexandria × Corinthe Noir. Both these selections produce parthenocarpic seedless fruit, in contrast to some seedless varieties which produce fruit in which seed development is initiated with failure of the seed to mature. The currant-type of fruit as produced by the Corinthe Noir variety is without even vestiges of a seed.

Greece from which early shipments of this dried fruit originated. "Zante Currant" grapes are now also grown commercially in California and Australia.

The "Zante Currant" grapes have small seedless berries which develop without fertilization of the ovules[3] since seed development is not initiated. The term "parthenocarpic" seedless has been applied[4] to this type of seedless grapes to distinguish them from other seedless types in which fertilization does take place and in which varying degrees of seed development can easily be noted. The parthenocarpic seedless grapes are characterized by small spherical berries, about ¼ inch in diameter illustrated in Figure 4 by a producing vine of the Corinthe Noir variety.

No definite information is available concerning the origin of the "Zante Currant" grapes. In connection with the grape breeding investigations at Fresno, California, new currant-type seedless forms have been developed which closely resemble the "Zante Currant" type. One currant-type originated as a chance mutation while a number of similar types have been produced as a result of controlled grape crosses.

The chance mutation which produced the currant-type seedless grape occurred on a portion of a 27-year-old Muscat of Alexandria vine on the property of Mr. E. W. Eckard, near Fresno, California. While this mutation represents a seed-



A SEEDLESS MUSCAT OF ALEXANDRIA

Figure 6

A—shows a cluster from a seedless mutant, compared with a cluster of normal Muscat of Alexandria (*B*). Frequently these mutants transmit seedlessness to their progeny in the first or second hybrid generations. They are therefore valuable in breeding projects even when their quality is not such as will make them important as commercial varieties. Approximately one-half natural size.

less type developing from a seeded variety, a previous report[5] has also indicated that a grape having seeds may arise as a mutation from a seedless variety. The chance seedless mutation was noted in 1935. One portion of the Muscat of Alexandria vine produced clusters of seedless fruit while the remainder of the vine produced normal Muscat of Alexandria clusters. Cuttings taken from the mutating portion of the vine were propagated and have produced the same type of seedless fruit. (Figure 6.)

The vine of the mutating type is more vigorous than the normal Muscat parent vine. The internodes of the mutant are shorter, the leaves are thicker and decidedly glossy in appearance. Measurements made of the mutant and normal types indicate that the internodes of the mutant are 29 percent shorter than the normal. The leaf petiole of the mutant averages 24 percent shorter than the normal. Although the leaf blades of the two types do not vary widely in size, the leaves of the mutant average 14 percent heavier than the normal, indicating their thicker texture. Since the vine characters somewhat resemble tetraploid forms of *Vitis*, an examination of the root tips was made to determine the chromosome number. Dr. Haig Dermen at the U. S. Horticultural Station, Beltsville, Maryland, made the cytological examination

and ascertained that the mutant form was not a tetraploid but had the normal diploid number of 38 somatic chromosomes.

The striking difference of the mutant form occurs in the shape, size, and type of fruit. The normal Muscat berry is obovoid, somewhat variable in size, averaging ¾ inches in diameter and an inch in length. The berries may contain from two to four or more seeds with some seedless berries scattered through the cluster. The mutant berries range from spherical to slightly oblate, small in size, ¼ inch to ⅜ inch in diameter and contain no seeds. Figure 6 shows a cluster of the mutant seedless (*A*) and the normal Muscat cluster (*B*).

When dried the fruit of the mutation makes a currant-type raisin with a Muscat flavor. More time is required to ascertain the commercial possibilities of the new mutation. In grape breeding this type offers a seedless Muscat-flavored grape to cross with seeded Muscat types for the production of desirable muscat-flavored progenies with the seedless character.

Currant-type seedless grapes have also been produced by breeding. In recent years at Fresno, California, the progenies of controlled grape crosses have given a number of currant- or parthenocarpic-seedless types. The first parthenocarpic-seedless seedling occurred in the F_1 generation of Muscat Hamburg × Black Monukka made in 1928. This parthenocarpic seedless type, Figure 5*A*, was one of 29 progenies of this cross which fruited. Similar parthenocarpic seedless types have been obtained from F_2 seedlings, especially where a seedless variety was the male parent of the original cross.

Two parthenocarpic seedless seedlings were also obtained in the F_2 generation where both of the parents were seedy varieties, namely, Olivette Blanche × Muscat Hamburg. Table I indicates the original parentage of the F_2 seedlings and the number of progenies with the parthenocarpic fruit.

A typical example of the production of a parthenocarpic seedless grape by breeding is illustrated by the cross of Muscat of Alexandria × Corinthe Noir. This cross in the first generation produced all seedy progenies. A black-fruited seedling of this cross was self-pollinated and produced two seedlings of the parthenocarpic seedless type out of 14 seedlings which fruited. A cluster of one of these seedlings, white in color of fruit, is shown in Figure 5*B*.

Summary

A currant-type seedless grape has originated as a mutation which when propagated has perpetuated the mutant type. Controlled grape crosses have also produced parthenocarpic or currant-type seedless progenies. Parthenocarpic seedless types appear more frequently in the F_2 than in the F_1 seedlings. These seedless types closely resemble the "Zante Currant" seedless varieties. The production of these seedless types by breeding is important because it may be possible to obtain a currant-type seedless grape which will produce commercial crops without the necessity of annual ringing.

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TABLE I. Segregation in F_2

Parentage of F_2 seedlings	Number fruiting	Number parthenocarpic
(Muscat of Alexandria × Black Monukka) selfed	71	5
(Muscat of Alexandria × Corinthe Noir) selfed	14	2
(Muscat of Alexandria × Corinthe Rose) selfed	21	3
(Muscat Hamburg × Black Monukka) selfed	25	4
(Olivette Blanche × Muscat Hamburg) selfed	19	2

HEREDITARY EPISTAXIS IN MAN

HAROLD KENNETH FINK
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IT is a common observation that high altitudes, extreme weariness, overexercise, or excitement and temporarily high blood pressure can cause nosebleeds in people who do not ordinarily have them. In the typical case of Miss *X*, whose job kept her on her feet long hours, nosebleeds would occur especially when very fatigued, or just prior to menstruation. But in such individuals, the annoyance is not a continually repeated occurrence.

Abnormal bleeding is the result of either weak blood vessels, poor clotting mechanism, or both.[2] Purpuras, according to Davenport, have two conditions: (1) apparently not hereditary, due to weak vessel walls; and (2) caused by deficient clotting and possessing "perhaps a dominant heredity." Hemophilia, he continues, has been declared by Baar[1] to be due probably to insufficient prothrombin for the clotting reaction. Hemophilia, of course, is accepted to be a sex-linked recessive character, carried by the female in heterozygous condition, but showing only in males; no well-authenticated case of a homozygous hemophilic female exists, according to the records examined by Davenport, because zygotes with two recessive hemophilic genes, one in each *X*-chromosome, probably die before birth.[2]

The Family

The following study deals with a Northeastern United States case ("A") of inherited predisposition to *recurrent nosebleeding,* appearing at about the time of puberty, or slightly earlier, in the individual's development. The earliest available record is of I-1 ♀ (Figure 7) and 1-2 ♂, of good families, the latter born in 1749. (II-2 ♂ in 1773, III-2 ♂ in 1810, and IV-4 ♂ in 1846). Facts are lacking concerning ramifications of the main genealogical trunk till generation IV. VII-1 ♀ is at present only four months old, therefore unclassified, as is also VI-3 ♂ who died (pneumonia) at four and one-half years, too young to show evidence of the affliction.

Type of Inheritance

The pedigree indicates a dominant character, likewise affirmed by other pedigrees of epistaxis: Dr. Barbara S. Burks of the Carnegie Institute of Washington has kindly informed me that the Genetics Record Office at Cold Spring Harbor contains an epistaxis file, including fifteen pedigrees, showing the character to behave (like Case *A*) as a Mendelian dominant. "A number of the pedigrees," she writes, "have telangiectasis (red spots on skin) associated with epistaxis. One, however, in which nosebleed is associated with catarrh, shows through three generations a transmission of the trait from male to male." The last-mentioned case is probably also of dominant type, and though in these three generations sex-limited, affected females might be expected to appear, were further generations studied. This case, medical records, and pedigree *A* presented herewith concur in the inference that males have a greater susceptibility to the disease than females (Note IV-5 ♀, unaffected, as compared with V-1 affected ♀). V-4 and his sons, VI-2 and VI-5 all were addicted to colds and mild cases of flu, while the sons both had nasal infections in their youth.

In commenting on a case reported by Babington (first published in the *Lancet,* September, 1865, p. 36); Dr. E. C. Morgan[4] writes: "A tendency to epistaxis is occasionally hereditary. Families the subject of hemorrhagic diathesis (predisposition) may likewise inherit a special tendency to nosebleed. Babington recorded a remarkable instance in which six females, like their mother, suffered from frequent nosebleeds."

The author knows of no case where

two sufferers from epistaxis have married. Whether two doses of the gene or genes involved may be more deleterious than one, is hard to surmise. Being neither a very serious nor a noticeable character, it is not one to influence or restrict mate selection, and since not lethal, it may be expected to last indefinitely in the population.

Severity of Bleeding

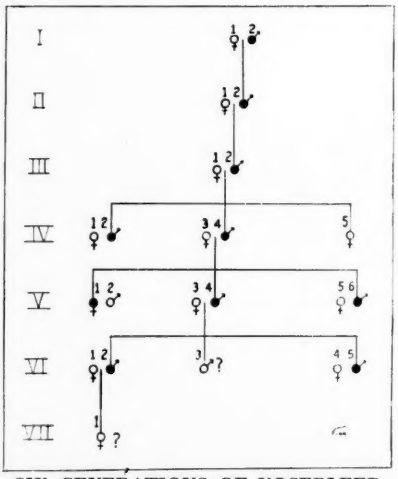
V-4 ♂ was born in 1881, and says of his father, IV-4: "He would get nosebleeds so bad at times that he would grow faint." Most of the Case *A* individuals can remember a first or near-first nosebleed in their early teens, which was excessively severe and prolonged; in later years the intensity seems to decrease, and milder instances of the affliction are more common. V-4 recalls a Greek examination cut short by a long, debilitating nosebleed.

VI-2 ♂ (born 1911) informs me: "I have always had trouble with nosebleeds, and with infections, etc., in my nose. Most of the trouble occurs when I have a bad cold with a 'clothes-pin' nose. High mountains do not bother me particularly. In the summer, I generally have less trouble. It is the very dry heated air (indoors) of winter that bothers me most. When my heart is beating fast, other conditions being equal, I am most apt to have distress. I am not bothered much by nosebleeds at present, but when they once come, I may have the attacks for several days."

VI-5 ♂ (born 1916) tells of a memorable first "big bleed" at the age of thirteen, lasting over an hour while outstretched on a train seat. After this early experience, none were so extreme, and, although a few later ones can be remembered as lasting fairly long, none are of such duration at present. In fact, he says: "During recent years, potential nosebleeds may start, but stop immediately or in a minute, with little loss of blood."

Treatment

Epistaxis of the type considered here, is basicly due to weakness in the minute capillaries of the mucous membrane of the nose, so that any slight irritation may puncture the vessels and permit blood-loss. The trouble is particularly evident in winter when resistance is low, and colds are prevalent; excessive blowing of the nose during a cold favors the rupture of the capillary walls.



SIX GENERATIONS OF NOSEBLEED

Figure 7

The preponderance of males is probably due to a greater susceptibility of males to the disease than females. Nosebleeds first occur at about an age of fifteen. They may be controlled by adding calcium to the diet.

Treatments tried by Case *A* members have been various; acid cauterization is only temporarily beneficial, but none have experienced the more permanent electric cauterization, the bother and expense of which are unnecessary if a simpler dietary method is utilized.

Calcium lactate — milk calcium, $Ca(C_3H_5O_3)_2 + 5H_2O$ — has been used in the past by the medical profession as a blood coagulant, in hemophilia, purpura, and after operations. The oral dose suggested to increase blood coagulation is 30-60 grains, subcutaneously in hemophilia, 2-4 grains.[5] Protoplasm itself may evince a "clotting reaction comparable in many ways to blood clotting," when calcium is in high concentration in the cells.[3]

There has been an apparent decreased

intensity of the bleeding in Case *A* from generation to generation, probably through better techniques of treatment, and generally improved health and living conditions in this country, in contrast to two hundred years ago. Treatment with calcium lactate (in powder form in foods, or more conveniently, five-grain tablets, taken with water in times of distress, or during periods of overwork, insufficient rest, etc.) has been successful in diminishing both the frequency and the intensity of the bleeding. But although this has proven the best of treatments used, it has been tried only in generations V and VI, and, as would be expected, the character is still passed on in the usual fashion. The two men of generation VI serve as control and experimental individuals, respectively, in determining the efficacy of calcium treatment in epistaxis, for VI-2 does not, and VI-5 does, employ an extra supply of calcium in the diet.

In World War I, calcium lactate was administered at Munich to men with open wounds, and healing was reported as over twice as fast, — and today it is in use at U. S. Army and Navy Hospitals. Hearing of this, V-4 tried it himself. In his own words: "Some years ago, I submitted to a complete chemical examination: blood, urine, etc., and the report showed conclusively that I was decidedly calcium deficient. I believe that I have 'cured' myself by bringing up the calcium content in my blood." (By the word "cured" he does not mean the removal of the predisposition but only of the symptoms; the capillaries are still fragile). His older son, VI-2, states: "I don't take calcium; my remedy is application of cold and rest," but without calcium, he admits (as quoted above) that he "may have attacks for days." VI-5, on the other hand, takes calcium whenever a speck of blood shows as a warning on his handkerchief (only *ca.* 25 grn. at a time is sufficient for him), and this is no more than a few times a month at the most. Were he to take extra calcium continually in his diet as his father does, he might be expected to lose even this last evidence of the affliction.

In the normal clotting process, it is well known that several elements are essential; ionic calcium is normally present to some extent in the blood stream. In the human lungs, the platelets release thromboplastin; prothrombin (formed in the liver) changes to thrombin in the lungs, only in the presence of thromboplastin and ionic calcium. The resultant protein thrombin, added to fibrinogen, another protein in unclotted blood, produces the fibrin threads which do the actual work of clotting. Thus calcium is an important link in the chain of events, and its increase in the blood of these two individuals in Case *A* improves the efficiency of the entire process. It is believed by some that vitamin *D* is necessary for proper absorption of calcium in the blood, but neither V-4 nor VI-5 have taken extra vitamin *D*; possibly, most healthy individuals have a sufficient daily supply of *"D"* to absorb extra calcium.

In discussing anti-bleeding treatments, one must not fail to mention the two recent discoveries which have received so much comment: Drs. Almquist and Klose of the University of California at Berkeley have discovered the anti-bleeding property of vitamin *K*; and Drs. Seegers, Warner, Brinkhous, and Smith of the State University of Iowa have obtained from beef blood (and beef lung) a more potent and more highly purified thrombin than heretofore available. Vitamin *K* in the diet may be expected to offer bleeders of different types the best remedy thus far obtained. While vitamin *K* is dietary, thrombin is for direct application to bleeding vessels.

Summary

1. Epistaxis in man is inherited as a Mendelian dominant, as evidenced by a six-generation study (Case *A*) and other records.

2. Epistaxis may be associated at times with telangiectasis, and/or general susceptibility to colds and nasal infections.

3. The severity of the affliction in

different individuals of Case *A* and the modes of treatment are discussed.

4. Diet and treatment are believed to explain the decrease in frequency and intensity of the symptoms that has been observed from generation to generation.

5. An additional supply of Ca-ions in the blood stream has been found to mitigate the distress to a marked degree, but the inheritance is not thereby discontinued.

6. Case A individuals are characterized by weak vessel walls; not the bleeding itself, but the physical condition of the capillaries is apparently the direct phenotypic effect produced by the gene or genes responsible for epistaxis.

I wish to express my appreciation to Professor Colin G. Fink of Columbia University for assistance in gathering the statistics on Case *A*.

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PHARMACEUTICAL GENETICS AGAIN

IT would seem that the pharmaceutical industry continues to educate its clients in biology along the lined noted in our last issue. The failure to quote genetic sources continues to be a feature of this new literature. The history of the mouse's role in medicine is a fascinating one well told to the mailing list of the Winthrop Chemical Company.* Any geneticist familiar with Keeler's *The Laboratory Mouse, Its Origin, Heredity and Culture* (Cambridge, Harvard University Press, 1931), will smell something besides the laboratory in *Mice in Mythology*. What that other odor is we begin to suspect on page 3, wherein the derivation of the word "mouse" is explained: "The Sanscrit word for mouse, 'mush,' is derived from a verb meaning 'to steal,' so that even in the cradle days of mankind the predatory habits of mice were well known."

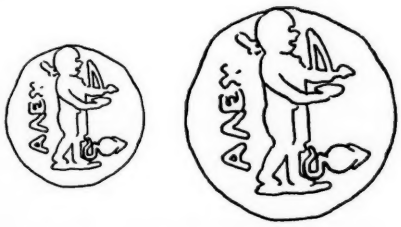
The significance of this bit of etymology to the publication in question becomes clear when we refer to Keeler, page 7: "In Sanscrit *Mush* is derived from a verb meaning 'to steal.' This suggests that man was well acquainted with the mouse and its predatory habits before the separation of the Aryan tribes . . . ."

The parallel is close here, but perhaps not close enough to justify a suspicion of literary "mushing" in the Sanscrit—not esquimoux—sense. But let us look further. Keeler, page 8, tells us: "Aelianus (c. A.D. 100) remarks that in Lower Egypt mice develop from raindrops. St. Basil (A.D. 330-379) repeats the story of pluvial generation . . . ." W. R. B. says: "Alianus, about A.D. 100, recorded that in Lower Egypt mice were generated by raindrops, and this fantastic story was repeated by later writers."

Keeler says, page 7: "In the holy city of Bast stood the famous cat mausoleum," while W. R. B. adds but one word: "In the holy Egyptian city of Bast stood the famous cat mausoleum."

On page 8, Keeler makes the unique suggestion probably not duplicated elsewhere in the literature: "Indeed, it may be suggested that rats and mice were probably responsible to a great degree for the cat's deification, because the Nile delta has been a grain-growing region since prehistoric times, and was undoubtedly overrun with these rodents before the advent of the Cat from Nubia." W. R. B. criticizes this specific idea: ". . . the precise factors responsible for the deification of the cat remain obscure. To

*W. R. B. Mice in Mythology and Medicine. "Clinical Excerpts" 14:3-6. Winthrop Chemical Company, 170 Varick St., New York, N. Y. 1940.



QUICK, WATSON, A MOUSETRAP!

Figure 8

Keeler's 1931 figure of Apollo Smyntheus is on the left; W. R. B.'s is on the right, larger than life, and twice as natural, as one might say. The 1940 figure is not credited to Keeler.

blame the mouse, which in a grain-growing part of the world like the Nile delta was the very incarnation of evil, though possibly accurate, is prosaic and mundane." But W. R. B. does not say who was so foolish to suggest such a "prosaic and mundane" idea, "though possibly accurate."

Keeler continues, "In Japan the mouse of the folk-sagas is a very wise creature and the symbol and messenger of the God of Wealth, Daïkoku. The god is usually represented as standing upon two sacks of rice with a mouse perched at his feet. The time between 11 P.M. and 1 A.M. is known as the hour of the mouse." W. R. B. comes pretty close with: "In Japanese folklore the mouse is a wise animal, being the messenger of Daïkoku, god of wealth, who is represented as standing or sitting on two sacks of rice and playing with a white mouse, while the time between 11 P.M. and 1 A.M. is known as the hour of the mouse." Here Keeler used a pen and ink drawing of a print in the Museum of Fine Arts, Boston, crediting the source. W. R. B. procured a photograph of the same print from the Museum of Fine Arts, Boston, to illustrate Daïkoku and his mouse.

One may also compare Keeler's Biblical quotations, pp. 8-9, about the Jews being forbidden to eat mice and the Philistines giving offerings of golden mice in the Ark with W. R. B.'s account, p. 5, of the same incidents in the same sequence.

But if you still believe that this is all coincidence and that W. R. B. had not received any inspiration from Keeler's book, which he fails to credit as a source material, just compare Keeler's pen and ink drawing, fig. 3B on p. 10, with W. R. B.'s figure of Apollo Smintheus and his mouse on p. 6. W. R. B. has not even redrawn the picture. In W. R. B.'s illustration you will detect all the idiocyncracies and irregularities of detail found in the picture that Keeler himself drew. The two drawings reduced in the same scale, are reproduced herewith. A *mousey* business indeed our Sanscrit linguistic forebears might have said!—R. C.

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WHENCE EUROPEANS?

"WHEN we see a new text," said a cynical representative of a large book company, "we look for the whizzer — the *one thing new* about it that justifies publication." *The Races of Europe* would give the hardened bookman quite a jolt. It is unique in arrangement, in illustrations, in factual material and in ideas. It sets a high standard as a text and will undoubtedly be widely employed as a reference. Coincidentally enough, it takes its place in the literature of Europe's physical and cultural history, just when the vigorous behavior of European races is in the forefront of all our minds. An American, who usually takes a deprecatory pride in hell-raising ancestors, can now get the low-down on them from a very complex and well documented source.

Professor Coon's anthropology is based upon measurement. "It has been borne home to me," he says in looking back on a rich anthropometric experi-

*Coon, Carleton S. *The Races of Europe.* The Macmillan Co., New York, 1939.

ence, . . . "that one good accurately measured study of a few hundred men, . . . is better than a general survey of a few characters on a million."

It is a rare page of the text that contains no figures upon heights, cranial, facial and other indexes. These mensural parentheses combined with a fine series of anthropological terms, makes it quickly obvious that even the prepared anthropology major will have lots of material to get his teeth into, while the tyro will find lots of material that gets in his teeth. Fortunately, a generous glossary containing everything he never heard of before, from *Aeneolithic* to *Zoned Beaker,* robs the lay reader of any excuse to leave lay such possible additions to his vocabulary. Appendix 1 of the text includes the data upon 53 series of a maximum of 21 skeletal character means based upon arrays of from 3 to 175 individuals each. Far from being satisfied with this, the author periodically comments, sometimes with acerbity, sometimes more in sorrow than in anger, upon the even greater accumulation of available series that has never been published. Books upon races usually contain some pictures of racial types, only too often the same pictures one can remember having seen in other books upon races, which makes the pictures reassuring without being very informative — except in those instances in which memory, we hope erroneously, suggests it has seen *that* physiognomy before as the perfect example of another race. *The Races of Europe* contains a photographic supplement of 46 plates most of them containing three different views of four carefully chosen individuals, in all about five hundred and forty photographs. There is an adequate number of very detailed diagrammatic maps.

The author's attitude in writing is that: "physical anthropology cannot be divorced from cultural and historical associations" for, "history allows determination of areas of racial dissemination in an otherwise apparent continuum." He doesn't include data upon blood groups; has strictly avoided comparisons of racial qualities and intelligence.

A Race By Any Other Name

What is a race? How does it fit into our taxonomic scheme? Even the Drosophilaphiles (or should it be Drosophilologists?) who know so much more about their subject organism than any other school, have not yet informed us, and Professor Coon finds human groups particularly variable and their phylogeny further tangled by past migrations and interbreeding. He uses the term race in a general, rather than in a specific, sense and assumes that the world contains six major races. *The Races of Europe* is concerned with a number of sub-divisions of one major race, the white race. These minor races include, beside the more widely known Mediterraneans, Nordics, Alpines, Dinarics and East Baltics, the less advertised but for the most part older Neo Danubian, Barreby, Tronder and Atlanto Mediterranean races.

The first part of the text runs chronologically from the Old Stone Age to the Iron Age. Five chapters present the author's opinion of how a Sapiens stock of domesticated foetalized ground apes, which had learned to grow food, successively entered Europe from the Southeast — met, mated with and successfully mulcted of their territory a more gorriloid and gerontomorphic group of food gatherers. These pedogenetic Sapiens people left the Swanscombe and (probably) the Galley Hill and Piltdown fossils. The paleanthropic pioneers are represented by Neanderthals and Neanderthaloids. Hybridization between some members of the two main groups produced Ekhul man of Palestine, the Afalou Crania of northern Africa and other Paleolithic types. Many subsequent crosses of both primary and secondary groups have been involved in the formation of Europe's present galaxy of races. In succession Mesolithic, Neolithic, Bronze and Iron age wanderers and invaders sailed or treked into Europe and by way of Professor Coon's fully documented pages enter into the ken of the reader. Living races have been considered geographically. If you want to find out about the Russians, the Finns, the English, the Germans, the Italians,

or the Balkan peoples, a rich reference source is available. The description of them takes five chapters of material which does not readily lend itself to summary.

The Place of Selection

Some brief comments will be made upon the author's opinions regarding matters of fundamental interest to general biologists. One of these is selection, which is discussed in more than one instance. An interesting and little advertized selective agency is emigration. Emigrants differ physically from the parent population which is therefore modified by their departure. Subsequent migrants differ physically from both the first immigrants and the new parent population. Another selective effect which the author considers important is the production of a certain physiological economy in response to nutritional deficiency (food, minerals or vitamins). There is the possibility of selection due to societal stratification based upon noticeable character differences, like pigmentation and body odor, combined with differential fertility. There is, of course, the climatological selection that is usually associated with the term.

Some considerable attention is given general population trends like brachycephalization and stature increase (or decrease) often involving "orderly increases at fixed rates of speed." There are a number of instances of original dolichocephalic populations becoming brachycephalic.

One of the best authenticated examples is from Bohemia, the pre-Christian grave material from which is "almost entirely dolichocephalic." By the ninth century the average cephalic index was 76-77, by the 12th 78, in the 16 century 80-81 and in the 18th century 85, — a steady and consistent increase in the width of the head. While admitting the probability that such changes may be in appreciable amounts the result of selection the author believes that some changes may be a "direct environmental effect." This belief is unaccompanied by any suggestion of what environmental agency is involved. Increases and decreases in stature are referred to obvious nutritional responses but here, as in the case of cephalic index, the author points out that an explanation may have to account for variants whose measurements exceed those of any known ancestor. Biologists are stubornly doubtful of the inheritance of direct effects of environment which are of an adaptive nature and will be inclined to note the author's comment upon the lack of any such pronounced trend in the British Isles which also lacks Alpine brachycephalic ingredients in the population.

Associated with the tendency for brachycephalization is that of reemergence. The primitive big-headed hunters and fishers were pushed out or superficially overrun by the incoming hordes of Mediterraneans and their blond Nordic brothers. Where they have been pushed to the fringes of Europe, in Ireland or Scandinavia, or where they have been in the way of traffic along the southern shore of the Mediterranean, the Paleolithic men (or women) merged with incoming populations. Subsequently, Paleolithic or Mesolithic types like Brunn, Barreby, and Afalou-like Riffians have reemerged. The author's thesis is that this may be due partly to individual survival and partly to a tendency for the various parts of the Paleolithic character complex to have more survival value when reassembled together than when separately incorporated with the characters of other types. They emerge for the same sort of reason that something a good deal like a Ford or a Buick might emerge from the fitting together of parts found disassembled in a wrecking yard, and that such "re-incarnation" would function better if it were mostly Ford or mostly Buick, rather than if it were half-and-half.

The author has a number of interesting theories of the effects of hybridization in the creation of racial types. His theory of the origin of the Dinaric race will be used as an example. This race, he believes, has been produced by a mixture of two-thirds Mediterranean and one-third Alpine ancestry. The latter's

round head is inherited, sometimes in an accentuated degree, in an inverted L-shaped area covering top and rear, while the pre-auricular portion of the skull is long like the Mediterranean type. This slopes the forehead back, makes the nose jut and sets the ears back near the nape of the neck. The face is narrow and may be exceptionally long. The final result is Dinaric in Europe, Armenoid in Asia and Nordic if depigmented. It seems probable that biologists will look at an explanation of this sort with a good deal of scepticism. Racial crosses with mammals have shown that some characters do behave as partial dominants but rather typically break up in succeeding generations of interbreeding.

An interesting sidelight is man's cynical disregard for the evidences of his own passing. Cremationists escape anthropometric pursuit by burning their nose bridges behind them. The author's pique with mute inglorious museums has been mentioned. In addition, important skeletal deposits have been discovered only to be thrown away. "What is man that thou art mindful of him?"

Rather more comforting is the assurance of the anthropological significance of commonly used words. Balts did live near the Baltic sea, Huns in Hungary, Danubians migrated by way of the Danube valley and a "squarehead" has a square head. These lattermost gleanings are registered to encourage prospective readers, daunted by the prospect of anthropological esotericisms, to go ahead and read an excellent book.

R. R. Huestis
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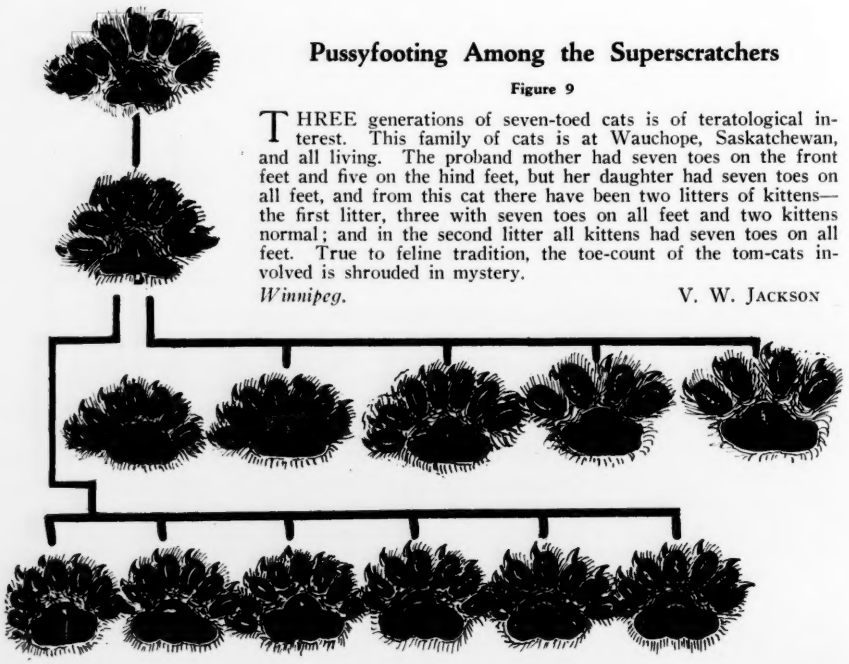
Pussyfooting Among the Superscratchers

Figure 9



THREE generations of seven-toed cats is of teratological interest. This family of cats is at Wauchope, Saskatchewan, and all living. The proband mother had seven toes on the front feet and five on the hind feet, but her daughter had seven toes on all feet, and from this cat there have been two litters of kittens—the first litter, three with seven toes on all feet and two kittens normal; and in the second litter all kittens had seven toes on all feet. True to feline tradition, the toe-count of the tom-cats involved is shrouded in mystery.

Winnipeg. V. W. Jackson

INHERITANCE OF HORNS AND SCURS IN SHEEP*

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A NUMBER of facts concerning the inheritance of horns in sheep have been known for many years. Both Wood[7,8] and Arkell and Davenport[2] have shown that, in crosses between certain horned and hornless breeds, the male offspring are all horned and the females all hornless. The latter, however, may develop "scurs" as they become old. These results have been explained by assuming that the gene for the horned condition is dominant in the male and recessive in the female. In the F_2 generation both horned and hornless animals occur in the two sexes, though the proportion of horned males is relatively great while that of the horned females is relatively small. According to the theory, only those females that are homozygous for horned actually show the character.

Since the purpose of this paper is to present some new facts and also to offer an explanation for some old, but imperfectly explained facts, it will be of advantage to use symbols for all of the genes concerned. Thus, in the crosses already given, one can use *H* to represent the horned condition and *P* (polled), the hornless. Capital letters are used for both allelomorphic genes, since dominance is different in the two sexes:

		Sons	Daughters	
$HH \times PP =$	*HP*	horned	hornless	F_1
	HH	horned	horned	
$HP \times HP =$	*2HP*	horned	hornless	F_2
	PP	hornless	hornless	

It is evident that the expected ratio in the F_2 generation is three horned males to one hornless, and three hornless females to one horned.

The pure breeds of sheep involved in the above cross are of two distinct kinds. In one, as for example the Dorset Horn, both sexes are horned, while, in the other, both sexes are hornless. An example of the latter is the Suffolk breed. There are, however, yet other pure breeds in which all of the males are horned while the females are all hornless. Such a breed is the Rambouillet. So far as we are aware, no satisfactory genetic explanation has been suggested for this condition. Results published by Arkell[1] furnish material for such an explanation.

Before giving Arkell's data it may be of advantage to state the theory, thereby making it possible to explain Arkell's results as they are being presented. The theory, in brief, is that the Rambouillet breed is homozygous for horned (*H*), but is also homozygous for a recessive gene (*hm*, horn modifier) which causes the female to be hornless. Thus the breed is of the composition *HH hmhm*, while the ordinary horned (in both sexes) breeds are *HH HmHm*. Expressing it in other terms, one may say that the *hm* gene in the homozygous condition makes the horned character completely limited to the male sex in what would otherwise have been a horned breed (*HH*).

The formula *HH hmhm* represents the composition of the Rambouillet breed of today. Arkell makes statements, and in addition gives results of crosses to show, that in his time, and previously, animals were produced which could not be explained by this formula alone. One would have to assume that in the early history of the breed the hornless gene (*P*) was also present in a fairly large proportion of individuals. The chief evidence for this is that hornless males were occasionally found. Such males could be

*Contribution No. 137, Department of Animal Husbandry.

produced from parents that apparently were of the correct breed type, so far as horns were concerned, but both would have to be heterozygous (*HP*).*

Arkell's Table IX contains results which can be explained on the assumption that at least two of his Rambouillet† females, mated to a Dorset Horn (*HH HmHm*) were of the same composition as the female parent in the above cross. The Dorset Horn male was mated to eight hornless Rambouillet females. Of the ten offspring, five were males and horned, but, of the five females, three were horned and two hornless.‡

The above cross shows how in Arkell's day some of the Rambouillet females, when mated to Dorset Horn males, could produce some hornless daughters. Present-day Rambouillets no longer carry the *P* gene. Therefore, when ewes of the breed are mated to Dorset Horn rams, all of the offspring are horned.||

In seeking an explanation for the presence of the hornless females in Arkell's Dorset-Rambouillet crossbreds, another possibility besides the one already given presented itself. This was that the Dorset Horn male was not homozygous for *Hm*, and that the Rambouillet female was similar to the modern type.§

The explanation apparently fits the facts, but, if there are heterozygous Dorset Horn males (*Hmhm*), there should also be heterozygous females. When two such horned animals are mated, one-fourth of the daughters should be hornless (*hmhm*). The difficulty is that hornless Dorset females are never produced, and have never been known to exist. This statement is based on answers to inquiries sent to a fairly large number of reliable individuals familiar with the Dorset breed. Thus one is forced to the conclusion that the progenitors of the breed were all *HmHm*.

Arkell and Davenport[3] make statements which lend support to the supposition that the Rambouillet breed (and Merinos in general) have not always been homozygous for *hm*. They state, "There is much evidence that in many long and carefully bred strains of Merinos the standard of hornlessness in the ewes is maintained only by hurrying the horned ewe lambs to the butcher." This means that thirty years ago, when the above statement applied, the gene *Hm* was still present in Rambouillets and in the other types of Merinos. Even though the horned ewes (*HH Hmhm*) were hurried to the butcher, it was nevertheless possible for the *Hm* gene to be carried by the males and its presence not be apparent phenotypically. The latter, in turn, would have some horned daughters; but, by a continual weeding out of

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*Horned male		Hornless female				Sons	Daughters
				HH	*hmhm*	horned	hornless
HP hmhm	×	*HP hmhm*	=	2*HP*	*hmhm*	horned	hornless
				PP	*hmhm*	*hornless*	hornless

†Arkell calls his animals "Merinos," but states that there are three kinds of Merinos—American, Delaine and Rambouillet. In his experiments he used Rambouillets almost exclusively. The only exceptions were a few American Merinos.

‡Dorset Horn Male		Rambouillet Female (hornless)				Males	Females
				HH	*Hmhm*	horned	horned
HH HmHm	×	*HP hmhm*	=	*HP*	*Hmhm*	horned	*hornless*

||Dorset Horn Male		Rambouillet Female (hornless)				Males	Females
HH HmHm	×	*HH hmhm*	=	*HH*	*Hmhm*	horned	horned

§Dorset Horn Male		Rambouillet Female				Males	Females
				HH	*Hmhm*	horned	hornless
HH Hmhm	×	*HH hmhm*	=	*HH*	*hmhm*	horned	*hornless*

such females, it gradually became possible to produce males all of which were *hmhm*. At any rate, no horned females are being produced at the present time in the Rambouillet breed.

Warwick and Dunkle[4] have furnished definite evidence that the Dorset Horns (*HH HmHm*) and the Rambouillets (*HH hmhm*) differ by only one gene, though their interpretation differs somewhat from the one herein presented, and may be read in detail in their paper. They mated an F_1 Dorset-Rambouillet ram (*HH Hmhm*) to purebred Rambouillet and Merino ewes and obtained 27 male offspring, all horned, and 22 female offspring, of which eight were horned and 14 hornless. The theoretical ratio in the daughters is 1:1, as shown in the cross.*

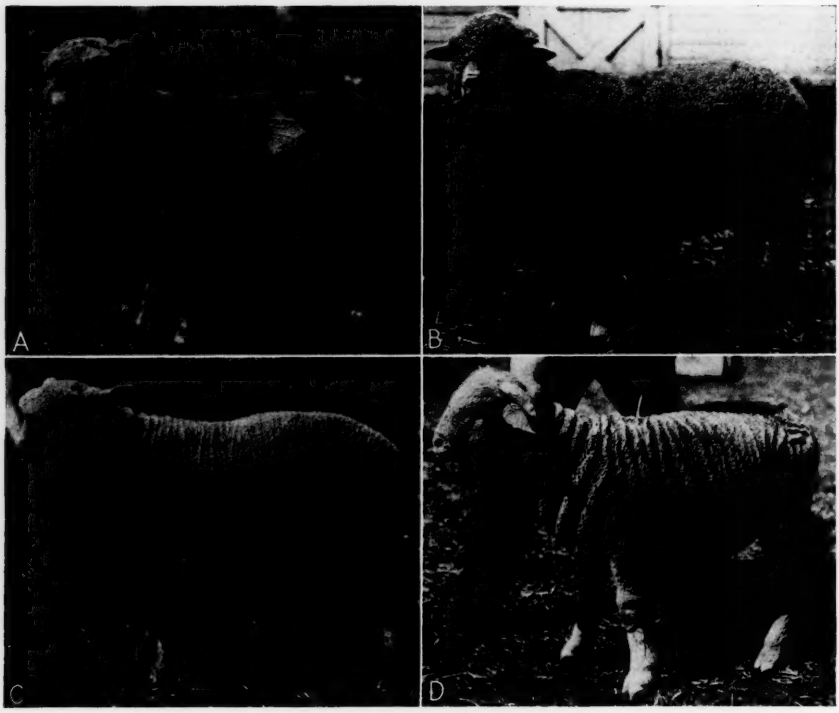
Some other results obtained fairly recently by Warwick and co-workers[5] have a very definite bearing upon the new material to be reported in this paper. They furnish evidence of the presence of a dominant horn-inhibiting gene in purebred Rambouillets. A number of polled males have been found in the breed, one of which has been shown to be a homozygous dominant. This animal, described in private correspondence by the senior author, is clean polled. When mated to typical hornless Rambouillet females, he sired 72 males, 39 of which had depressions in the skull where horns ordinarily appear, and 33 had scurs. His 90 daughters all had depressions.

Warwick and co-workers have used *H* to designate their "polled" gene, but, since *H* has already been used in the present paper in a different sense, it becomes necessary to use another symbol to designate their gene. The symbol *Ih* will be used, the "I" standing for inhibitor and the "h" for horn. Since Rambouillet females are hornless, there is no direct evidence from that breed that *Ih* inhibits horn production in female sheep. Until contrary evidence is obtained, however, there seems good justification for assuming that *Ih* is equally effective in both sexes. The only "proof" at present is that *Ihih* female Rambouillets have depressions (or "horn pits") in the skull while *ihih* animals of that sex do not.

Some further statements should be made concerning the *ihih* Rambouillet females. These, as pointed out, are the typical animals of the breed. Warwick and co-workers have examined "several hundred," and in every case noted that they had either "knobs" or "scurs." We have examined the 26 mature females of the Rambouillet flock at the Kansas Agricultural Experiment Station and have obtained similar findings. The clean knobs are bony protuberances of the skull in that region where the horns ordinarily appear. Those with scurs have them at the tips of the protuberances. Some animals have ordinary skin covering the protuberances, and have therefore "clean" knobs (Figures 11*A* and 11*B*). Others have merely some granular tissue covering the knobs (Figure 11*C*), and as a result are difficult to classify. The remainder have scurs of varying length and width (Figures 11*D*, 11*E* and 11*F*). Thus it would seem that *hm* in the homozygous condition does not completely inhibit all indication of horn formation in females of the Rambouillet breed. The mode of inheritance of scurs will be discussed later in the paper.

Taking into consideration all the horn genes discussed here, the composition of the ordinary purebred Rambouillet should be *HH hmhm ihih*, while that of a true breeding strain of polled Rambouillets should be *HH hmhm IhIh*. It may be of interest to point out that from a genetic standpoint most hornless breeds of sheep are merely *PP*. However, as we shall endeavor to show, there is good evidence that at least one hornless breed, the Southdown, at the present time also carries *Ih*. This may be brought out more effectively by con-

*Crossbred ram		Rambouillet ewes				Males	Females
HH Hmhm	×	*HH hmhm*	=	*HH*	*Hmhm*	horned	horned
				HH	*hmhm*	horned	*hornless*



HORNLESS SHEEP

Figure 10

A—Typical purebred Southdown ram, showing "horn pit" near base of left ear. Both sexes are hornless in this breed. This male is the sire of the crossbred animal shown in Figure 10*C*, thereby demonstrating that he carries the dominant horn-inhibiting gene, *Ih*. *B*—Typical purebred Rambouillet ewe. In this breed the males are horned and the females hornless. The female shown is the dam of the crossbred in Figure 10*C*. Her scurs are shown in Figure 11*E* She is heterozygous for the scur gene (*Sc*), and her scurs are therefore of intermediate length due to incomplete dominance. *C*—Crossbred ram lamb. Male parent is purebred Southdown (Figure 10*A*), and female parent is purebred Rambouillet (Figures 10*B* and 11*E*). He is hornless and has "horn pits" like his sire. Age, 73 days. Being without scurs, he is *scsc*. He carries the *Ih* (horn-inhibiting) gene contributed by his father. *D*—Typical purebred Rambouillet ram lamb. Age, 89 days. Shows contrast with crossbred lamb (Figure 10*C*) in regard to horn development.

trasting Arkell's Southdown crosses with present-day results.

Arkell's Table VII gives the detailed results from the crossing of Dorset Horns with hornless animals, most of which were Southdowns. His Dorset Horn male No. 2, mated to five Southdown females, sired seven offspring. These consisted of four horned males and three hornless females. The same Dorset male mated to two hornless "native" females sired two hornless daughters. In the reciprocal cross, Southdown male No. 4 mated to three Dorset females sired three horned sons and one hornless daughter. Thus Arkell's results so far as they go show that the five Southdown females and the one Southdown male tested all were of the composition *PP*, without any other complicating genes (such as *Ih*) being present. One of the five females, however, did not

have any sons. The presence of *Ih* in any of the females could be made manifest only in the sons. The latter, if they received the gene from their mothers, would be hornless (*Ihih HP*).

For a number of years Southdown rams have been mated to either grade Rambouillet or Dorset Horn ewes for the purpose of producing in some cases "hot house" lambs, in other cases, spring lambs. Almost invariably *all* of the offspring have been hornless like the Southdown sire. The male offspring from such a cross usually are castrated when about five weeks old, but, although castration has an inhibiting effect on horn production, the horns, if they were to be present, would have been fairly well developed at the time the gonads were removed. Thus the evidence points to the fact that the Southdowns as a breed are at the present time to a large extent homozygous for *Ih*, or at least for a gene having the same effect.

Evidence of a more concrete nature has been obtained recently at the Kansas Experiment Station. A purebred Southdown ram (Figure 10*A*) mated to a purebred Rambouillet ewe (Figures 10*B* and 11*E*) sired a truly hornless male lamb (Figure 10*C*). It will be noted that both the sire and the son have horn pits, while the dam has scurs (Figure 11*E*). A purebred Rambouillet ram lamb, sixteen days older than the crossbred is shown for comparison (Figure 10*D*). At the time the photographs of both were taken the crossbred was 73 days old.

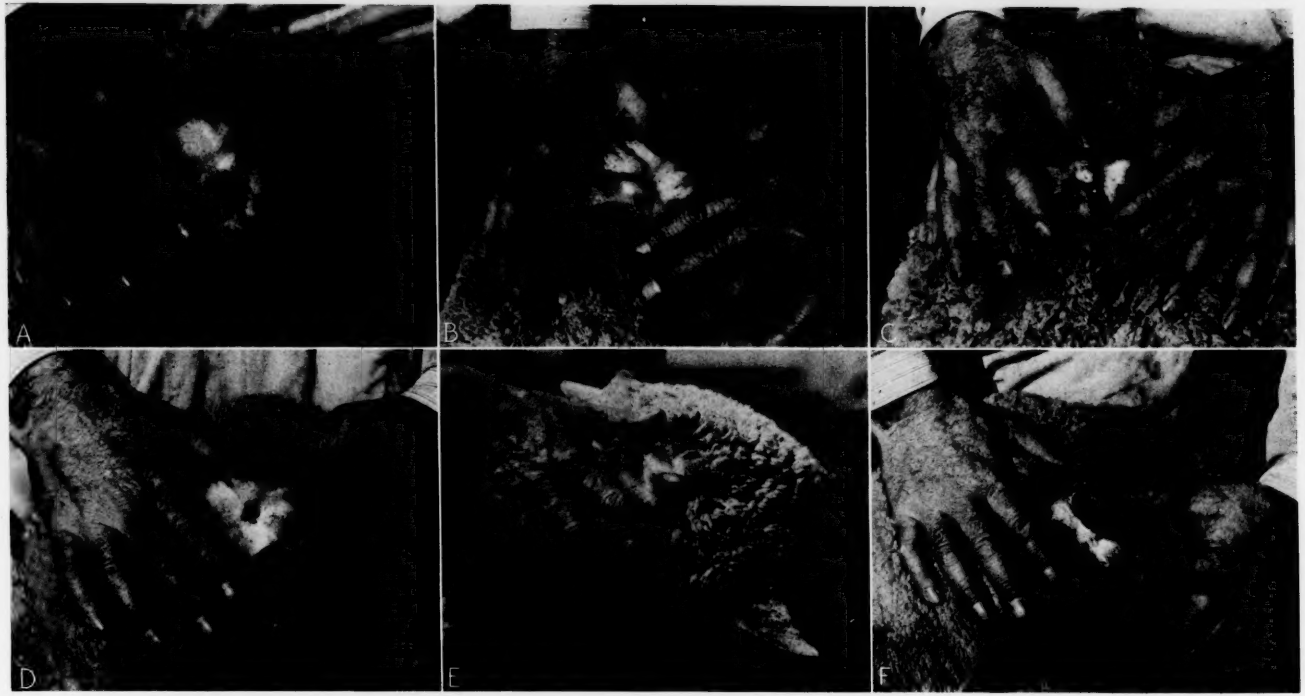
There is the possibility that the horn-inhibiting gene of the Rambouillet (*Ih*) is not the same as the one present in Southdowns, but, until crucial evidence to the contrary is obtained, it seems advisable to assume that the two are identical. One apparent point of similarity in the manifestation of the gene in the two breeds is the presence of horn pits in many of the animals carrying it. The only exceptions are one-half of the sons of the homozygous polled Rambouillet male.

We have examined many individuals in three hornless (in both sexes) breeds. These breeds are the Southdown, Shropshire and Hampshire. Invariably, each animal was found to have horn pits. Since the evidence indicates that most of these animals carry *Ih*, one might assume that the horn pit is an indication of the presence of the *Ih* gene. If that were the case, one would expect Arkell's animals to be devoid of pits since they all proved to be *ihih*. Some of his Southdowns are shown in his bulletin, but the photographs are either not clear enough or are not taken at the correct angle for determining with certainty whether the horn pits are present.

Arkell's Hampshire pictures, however, are much more satisfactory. His purebred Hampshire ewe, No. 110, very definitely has horn pits. When mated to a Rambouillet she gave birth to two horned male lambs (Arkell's Table VIII). This is at least an indication that she was *ihih*. There were also other matings between Hampshires and Rambouillets. Including the two offspring given above, the total F_1 animals from the cross are seven males, all horned, and sixteen females, all hornless. One of the F_1 ewes, No. 85, is shown. She also has horn pits. Thus there seems justification for believing that *Ih* was not carried by any of the purebred Hampshires used, and this in turn leads us to the conclusion that horn pits in hornless animals (*PP*) are not necessarily due to the *Ih* gene.

The fact nevertheless remains that the *Ih* gene is more prevalent in present-day Southdowns, Hampshires, and Shropshires than it was in their more remote ancestors. That the gene actually was present in early Southdowns, for example, is shown by pictorial records of crosses with horned breeds. Wallace[6] has a reproduction of a painting, made a number of years previously, showing a horned ewe and her male lamb by a Southdown ram. The lamb is fairly large, but is hornless. It must have received *Ih* from its hornless Southdown parent.

What has brought about this apparent increase in the number of *Ih*-carrying animals in hornless breeds? Only one possible explanation suggests itself at present. For many years, by continued



HORNLESS AND SCURRED SHEEP

Figure 11

A to *F* inclusive are close-up photographs of the head region of purebred Rambouillet ewes showing variations in the scur character (or its absence). *A*—Scur-less (*scsc*) animal having a small bony protuberance on the skull. *B*—A *scsc* animal having a higher protuberance. *C*—probably a *scsc* animal but the protuberance is covered with granulated skin. The ewe was more than nine years old at the time the photograph was taken. D—*Scsc* animal having a very small scur ("button"). *E*—A *Scsc* animal with a scur near the upper limit for length in heterozygotes. This was found on the animal shown in Figure 10*B*. *F*—A *Scsc* animal with long scurs. Incomplete dominance of *Sc* over *sc* in *ihih* animals is assumed tentatively in the present paper.

selection, scurs gradually have been eliminated from the hornless breeds. There is the possibility that in some manner, as yet unknown, the selection toward decrease in scurs has at the same time tended toward an increase of the *Ih* gene in the breed. This cannot be fully tested until more is known not only concerning the inheritance of scurs itself, but also in regard to the interaction of the scur gene (or genes) with other genes, such as *Ih* and *P*.

Inheritance of Scurs

Enough facts are available to build up at least a tentative theory for scur inheritance, and something is known regarding the interaction of the scur gene with *Ih*, but at present no information is at hand concerning its interaction with the hornless gene, *P*, found in typical hornless breeds. The absence of any knowledge regarding the last point makes it impossible to determine at present whether selection against scurs in a hornless breed (*PP*) has had the effect of increasing the number of *PP* animals which also carry *Ih*.

The theory in regard to scur inheritance is based on a study of the 26 previously mentioned Rambouillet females making up the Kansas State College flock. The explanation of the interaction of the scur gene with *Ih* is based on the paper by Warwick and co-workers[5] and on additional information kindly furnished by Dr. Warwick.

Of the 26 females in the Kansas State College Rambouillet flock 14 were found to be without scurs, but nevertheless having two bony protuberances of the skull which were covered with skin devoid of wool. Ten had small scurs, and two had comparatively large scurs.

The 14 females without scurs varied somewhat in the height of the protuberances on the skull. In some there was very little elevation (Figure 11*A*), while in others it was more pronounced (Figure 11*B*). All but one of the 14 had smooth, woolless, skin covering the protuberances. In the case of the exception the skin was granulated (Figure 11*C*). It is possible that since this animal is over nine years old, age may have been a factor in bringing about the condition. She has not been examined previously. Her daughter is shown in Figure 11*D* and her granddaughter in Figure 11*F*.

The ten with short scurs also varied within fairly well marked limits. The very short scurs are designated "buttons" (Figure 11*D*). A definitely longer short scur is shown in Figure 11*E*. One example of the long scur is shown (Figure 11*F*). This measures about one and one-half inches in length. It is twisted and therefore difficult to measure.

Many of the 26 females are related, which is an advantage when one wishes to build up a theory of scur inheritance. The data, though meager, fit in fairly definitely with the theory that scurs are due to an incompletely dominant gene, *Sc*, which expresses itself only in the absence of horns. Thus it has no visible effect in typical Rambouillet males. A homozygous dominant, *ScSc*, has long scurs (Figure 11*F*), a heterozygote, *Scsc*, has shorter scurs (Figures 11*D* and 11*E*), and a recessive, *scsc*, no scurs (Figures 11*A*-11*C*). It should be emphasized that the above is not true when *Ih* is present. According to the theory, the two females with the long scurs are *ScSc*, the ten with short scurs are *Scsc*, and the fourteen scur-less ones are *scsc*.

One important kind of evidence is lacking at present. None of the males has proved to be *scsc*. One of this kind, mated to scur-less females, should have only scur-less daughters. Two of the males (J. K. Madsen 5385-B and J. K. Madsen 2886-E), however, have proved to be *Scsc*. They have eight daughters in the flock at present by five of the scurless (*scsc*) females. The distribution is exactly according to expectation: four scurred and four scur-less. The same males mated to known heterozygous females have only one female offspring in the flock, and she is scurred (*Scsc*). Eight other females are the daughters of these males, but nothing is known regarding their mothers since they are no longer in the flock.

There is no direct evidence for the

assumption that *Sc* is incompletely dominant to *sc*. Neither of the two purportedly *ScSc* animals has had enough offspring to justify any conclusions based on a breeding test. All of the evidence is indirect. First, the two have scurs definitely longer than the ten classified as heterozygotes. Second, one would expect a relatively small number of homozygotes (*ScSc*) in a flock where 14 of the 26 females in it are recessives (*scsc*). Third, although the genetic composition of both parents of the two animals is not known in either case, it is known for one parent of each. Both of these animals are known heterozygotes (*Scsc*), and could therefore have homozgous dominant offspring.

The explanation for the interaction of the dominant horn-inhibiting gene, *Ih*, with *Sc* is based on the previously mentioned results published by Warwick and co-workers[5] and on information obtained privately from Dr. Warwick. The pertinent facts, obtained from both sources, are that two polled Rambouillet rams have been shown by breeding tests to be *IhIh*. One of these rams, whose progeny are listed in the published results, is without scurs, and the other, the data concerning whose offspring are not at present available, has scurs. The scur-less male, mated to a large number of typical Rambouillet females (*HH hmhm ihih*), some of which had scurs and the remainder none, sired 90 daughters all of which had no scurs or horns, but instead had small depressions in the skull. Of the 72 sons, 33 had scurs and 39 had only depressions.

The above results show that the *Ih* gene prevents the expression of *Sc* in *Scsc* females, but not in males of that composition. The scur-less homozygous polled male is *IhIh scsc*. When he is mated to scur-less females one would expect the offspring of both sexes to be without scurs:

IhIh scsc × *ihih scsc* = *Ihih scsc*

When this male is mated to *Scsc* females, all the daughters are clean polled, but half of the sons have scurs:

IhIh scsc	×	*ihih Scsc*	=
		Sons	Daughters
Ihih Scsc		*scurs*	no scurs
Ihih scsc		no scurs	no scurs

It will not be necessary to show that if this male were mated to *ScSc* scurred females, all the sons should be scurred and all the daughters clean polled.

Warwick and co-workers do not state what proportion of the dams (mated to the *scsc* male) in their experiment had scurs, but, if the theory is correct, one would expect, judging by the large number of scurred sons produced, that a fairly large proportion (at least one half) showed the character. This would be true especially if only a small percentage of the mothers proved to be *ScSc*. It is not possible to determine from the data at hand whether a *ScSc* female is scurred in the presence of *Ih*.

Cornell Data

Many of the statements and deductions made in this paper are based on information received from various reliable sources. During the course of some correspondence with Dr. John P. Willman of Cornell University, data bearing on the characters discussed above were kindly sent us by Dr. Willman. These data are incidental to Dr. Willman's "stiff lamb" experiment.

In his experiment three different purebred Dorset Horn males (*HH HmHm ihih*) were used. The females were of three different kinds. In one kind the six individuals were all Dorset-Delaine Merino crossbreds, and all were horned. Dr. Willman states it has been his experience that only horned animals are produced when purebred Dorsets are mated to purebred Merinos. This is in line with what has been previously stated in regard to present-day Dorset-Rambouillet (Merino) crossbreds (*HH Hmhm ihih*).

The other two kinds of females have been grouped together as "White-faced Westerns" which differ somewhat in their breeding. Both are called grade (not purebred) Rambouillets. All of these females were hornless, but in one kind (as classified by Dr. Willman) there is evidence of much Rambouillet

breeding, and in the other the Rambouillet characteristics show to a definitely lesser extent. The latter belong to a type, common in some of the western states, which has an admixture of so-called long-wool breeding. In long-wooled sheep the fleece is coarse, while in Rambouillets, and Merinos is general, the fleece is shorter, but is fine. Some of the long-wooled breeds that have been used in these crosses are the Lincolns, Cotswolds and Romneys. Another breed, the Corriedale, has also been used extensively. It is neither extremely fine-wooled, nor extremely long-wooled, but is a combination of the medium grades of both characters and has been produced in Australia through cross-breeding and selection.

All of the four non-Rambouillet breeds above enumerated have one characteristic in common. This is that the individuals of both sexes are hornless. One therefore expects them to be *PP,* like other hornless breeds, with the possibility that *Ih* also is present. The results obtained by Dr. Willman prove this to be the case.

The offspring obtained when two purebred Dorset Horn rams were mated to the six previously mentioned Dorset-Delaine Merino crossbred ewes consisted of eight animals, three males and five females, and all were horned. This is according to expectation:

Dorset Horn Males		Dorset-Delaine Merino females		
HH HmHm ihih	×	*HH Hmhm ihih*	=	
		Males		Females
HH HmHm ihih		horned		horned
HH Hmhm ihih		horned		horned

It will be noted that it is a reciprocal of the cross reported by Warwick and Dunkle.[4]

The high "grade" Rambouillets are the result of the continuous use for a number of generations of purebred Rambouillet rams on an originally mixed stock. One would expect such animals to have lost to a large extent the *Ih* and the *P* genes, if they were ever present, and therefore be similar to the Rambouillets. Dr. Willman's results are in accord with this assumption. His three purebred Dorset Horn males were mated to eleven high-grade Rambouillets. If the latter had been purebred, all of the offspring would have been horned. Actually, there were eight male offspring, all horned, and three female offspring, two of which were horned and one hornless, the last mentioned being the exception. The chances are its mother was *HP hmhm ihih,* while it itself was *HP Hmhm ihih,* and therefore hornless because of *P*. The *Ih* gene is ruled out to some extent as a possible explanation for the hornless female because if it were present in the grade Rambouillets there would be the possibility of one or more of the eight male offspring being hornless. None of the males could be made hornless by the *P* gene since it has no effect in heterozygous (*HP*) animals of that sex.

Dr. Willman knows nothing concerning the immediate parents of the 11 low-grade Merino females that were used in his experiments. Their appearance, however, indicated considerable long-wool breeding. His results show that both the *Ih* and the *P* gene were common in the stock. When purebred Dorset rams (*HH HmHm ihih*) were mated to these females, the offspring consisted of four horned males, one *hornless* male, one horned female and seven *hornless* females. The hornless male offspring must be due to the *Ih* gene, and the same gene may have caused hornlessness in one or more of the seven hornless daughters. The remaining hornless daughters would be carrying the *P* gene.

If it were considered of sufficient interest to justify making the test, one could determine whether the seven hornless daughters carried the *Ih,* or *P,* or both, genes, by mating them to purebred Dorset Horns. If there were any hornless sons, this would indicate that *Ih* was carried. If the numbers were fairly large, and the only hornless offspring were females, it would be a proof of the presence of *P*. If hornless were found in both sexes, but the proportion or hornless females was definitely greater, it would be proof that both *Ih* and *P* were carried by the female being tested.

Summary

In the following summary only two of the four factor pairs discussed have been suggested by us. These are *Hm, hm* and *Sc, sc*. We have taken the liberty, however, to use new symbols for the other two, and, so far as the known facts will permit, have proposed an explanation of the interaction of all four pairs.

1. First factor pair, *H* (horned) and *P* (hornless). *HH* animals of both sexes are horned, provided other genes, mentioned later, do not interfere. *PP* animals of both sexes are hornless. In heterozygotes (*HP*), *H* is dominant in males and *P* in females.

2. Second factor pair, *Ih* and *ih*. Dominance is complete in both sexes. *Ih* inhibits horn production. Therefore *Ihih HH* animals of either sex are hornless. Animals of the composition *ihih HH* are always horned if males, and usually if they are females. The exceptions in the case of the females are due to interaction with the third factor pair.

3. Third factor pair, *Hm* and *hm* (horn modifier). *Hm* merely prevents *hm* from having any effect. *HH hmhm* animals are horned if males, but hornless if females. Purebred Dorset Horns are *HH HmHm ihih*, while the usual purebred Rambouillets (whose males are horned) are *HH hmhm ihih*.

4. Fourth factor pair, *Sc* (scurs) and *sc* (absence of scurs). These genes manifest themselves only in hornless animals. In purebred Rambouillet females, *Sc* is incompletely dominant. Therefore *ScSc* animals have longer scurs than do the heterozygotes. Females of the composition *scsc* have two protuberances in the skull, but no outgrowths. The genetic composition of the horned Rambouillet male in regard to the scur genes can be determined by means of his daughters, especially when he is mated to scur-less (*scsc*) females.

5. The *Ih* gene affects the expression of the *Sc* gene in purebred "polled" Rambouillets. In *Ih* females *Sc* has no effect in heterozygotes (*Scsc*). It is not known whether scurs show in homozygous females (*ScSc*) carrying *Ih*. Scurs, however, do appear in *Scsc Ihih* hornless Rambouillet males. Purebred, true breeding, "polled" Rambouillet sheep will be of the composition *HH hmhm IhIh*. At present they vary in regard to *Sc and sc*.

6. All of the sheep breeds which are hornless in both sexes (except the "polled" Rambouillets) are *PP*. The *Ih* gene also is to be found in many present-day hornless individuals, but it apparently was less common in the early ancestors of the breed. No satisfactory explanation can be found at present for this change.

7. Nothing seems to be known at present concerning the effects of sex in the expression of the *Sc* gene in *PP ihih* animals.

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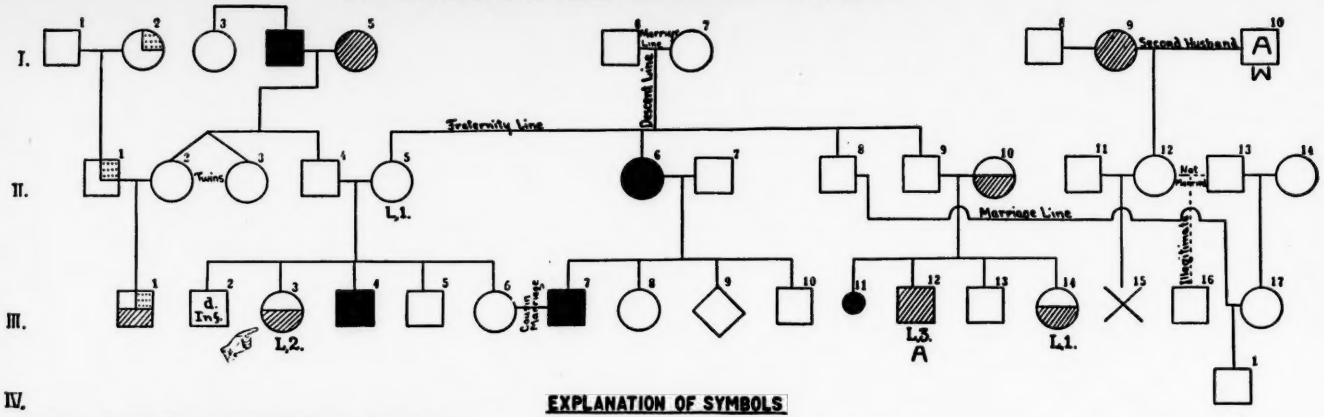
SAMPLE PEDIGREE CHART SHOWING THE MANNER OF CONSTRUCTION, AND THE USE OF STANDARD AND SPECIAL SYMBOLS.



EXPLANATION OF SYMBOLS

(a). Standard for all Pedigree Charts:

□=Male; ○=Female; ◇=Sex unknown; ●=Still-birth or Miscarriage; X=Children — number and sex unknown; ○○=Twins; d.Inf.=Died in Infancy; ☞ Points to the Propositus or central figure in the pedigree.

□—○=Parents.

□○□○○=Children.

Roman figures to the left indicate generations; Arabic figures locate individuals, (thus III.7 is the young man in the third generation who married his cousin).

The following letters, placed in or around the individual's pedigree symbol, are standard for certain traits: A, alcoholic; B, blind; D, deaf; E, epileptic, F, feebleminded, I, insane, M, migraineous; N, normal in reference to traits under consideration; Ne, neurotic; P, paralytic; Sx, sexually immoral; S, syphilelic; T, tuberculous; W, wanderer.

(b). Especially devised or selected for this particular pedigree-chart:

■ ● = Successful leaders in politics. ◱ ◔ = Extra thumb on right hand. L.1.=Highly successful author. L.3.=Little or no ability in literary efforts. ▨ ▨ = Superior in vocal music. ▨ ▨ = Medium attainment in vocal music.

To fit the particular family and traits (whether physical, mental or temperamental; good or bad) under consideration, invent special symbols, or select special letters (in addition to those standardized under (a) above) to be placed within or near the particular individual's pedigree symbol, to indicate particular traits and their degree of development.

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